Chemical Cleaning

(Descaling) of Shipboard Cooling Equipment and Systems

The Evolution of a Good Pollution Prevention Idea

Did you ever wonder how a good pollution prevention (P2) idea gets implemented? At the Naval Sea Systems Command (NAVSEA), what started as a good idea to improve a maintenance process in the Carrier (CV)/Amphibious Ship Engineering Program Manager Support Office (Code PMS 307), and a hazardous waste challenge at Portsmouth Naval Shipyard (PNSY), have evolved into a improved decaling process with an average saving of over $ 520,000 per submarine cooling system and up to $70,000 for individual heat exchangers.

Seawater heat exchangers on board Navy ships and submarines scale up and become less effective during normal ship operations especially in warmer waters. "Descaling" these exchangers using traditional methods is labor intensive, involves hazardous materials and wastes and safety risks.

In September 1998, the NAVSEA P2 Working Group (P2WG) established by the NAVSEA Environmental, Safety and Occupational Health Office (SEA 00T) first identified this project at its annual brainstorming session. Darryl Sheedlo, NAVSEA PMS 307, recommended shipboard heat exchangers chemical cleaning become a P2WG Project. At the time, contractors working under direction to regional maintenance officers in Mayport, FL and Norfolk, VA were performing a new method of chemical cleaning on non-nuclear surface ship heat exchangers and were getting excellent results.

About the same time Tim Dunn, the P2 Manager at PNSY was working to decrease or eliminate hazardous waste generated by a hot sulfamic acid (trade name "amidosulfonic acid", formula NH2SO3H) descaling process at his shipyard. Sulfamic acid is a free flowing, non-hygroscopic, fine, white crystal that is also used for removal of grout and mortar haze, rust and mineral deposits. The process generated 80,000 pounds of acidic hazardous waste for each cleaning, placed the workers at risk from handling the hot acid, required considerable personal protection equipment and cost $.108 a pound for proper waste disposal. A local PNSY Process Instruction (PI) based on the requirements of a NAVSEA Ships Technical Manual specified this process. Tim thought there must have been a better way.

> The project ... brought the Acquisition, Afloat technical support and Ashore elements of NAVSEA together to work on a common challenge.

The P2WG determined the proposed chemical cleaning process needed further engineering and NAVSEA approval for use on all ships, at Shore Intermediate Maintenance

BEFORE

This is a High Pressure Air Compressor heat exchanger on the USS Valley Forge (CG-50) before cleaning.

AFTER

This is the same heat exchanger four hours later after cleaning. SIMA personnel at Naval Station San Diego performed the work, during a February 2001 availability. Notice the significant difference.

Activities and at the shipyards. In addition, NAVSEA had to evaluate long-term impacts on cooling system piping and heat exchangers. The project was designated a priority initiative by the P2WG because it had high priority in the fleet, and brought the Acquisition, Afloat technical support and Ashore elements of NAVSEA together to work on a common challenge.

The P2WG established a Chemical Cleaning and Descaling Sub-committee to define, address and resolve the challenges, and promote the use of this new process. Members represent a cross section of the NAVSEA community including representatives from the following organizations:

- NAVSEA Environmental, Safety and Occupational Health (ESOH) Office,
- Carriers, Amphibious, and Submarine In-Service Program Offices,
- NAVSEA and Carderock Seawater Systems and Chemical Cleaning Engineering Groups,
- Supervisor of Shipbuilding, Conversion and Repair (SUPSHIP), and
- Three Naval shipyards.

The subcommittee, with the support of the NAVSEA Engineering for Reduced Maintenance (ERM) Panel, evaluated the cleaning process. Once the evaluation was complete the subcommittee members agreed to modify the cleaning process to increase its effectiveness in removing the scale while minimizing the impacts on the copper nickel alloy (CuNi) piping. Engineered descaling processes were developed that outlined the steps used to chemically descale individual heat exchanger equipment and entire submarine cooling systems. The new processes were then tested at several Navy facilities. The processes use commercially available hydrochloric acid based products that are less dangerous but as effective as hot sulfamic acid and more cost effective than mechanical cleaning.

These processes were incorporated into a Universal Industrial Process Instruction (UIPI) for use at Navy shipyards, a standard work template (SWT) for use by SUPSHIP contractors, and the "Procedure for On Site Descaling of Heat Exchangers and Distilling Plants on Surface Ships" for Shore Intermediate Maintenance Activity (SIMA) use. Qualified SIMAs, contractors and naval shipyard personnel were authorized to use the processes.

The subcommittee members are also involved in other projects to enhance the process. The Naval Ship System Engineering Station (NAVSSES) in Philadelphia is currently developing a cooling system chemical cleaning performance specification. The Naval Research Lab (NRL) is evaluating the process to determine the long-term effect of copper removal, and on the

CONTINUED ON PAGE 78

CONTINUED FROM PAGE 77

oxide passivation layer on cooling system pipes. To date, NRL has tested Rydlyme's (hydrochloric acid base) effects on 70/30 CuNi. They have also been tasked with evaluating phosphoric acid base effects. NRL found that after cleaning with descalents, the relative kinetics of oxide film formation on 70/30 CuNi occurred at a slower rate with phosphoric acid base than with hydrochloric acid base.

The process has been used by Puget Sound Naval Shipyard (PSNS) since FY 1999. PSNS has cleaned 41 carrier and 2 Ohio Class submarine heat exchangers. In addition, five submarine Auxiliary Sea Water (ASW) cooling systems containing 8 heat exchangers, 3 pumps, 50 valves, and 450 feet of piping and one submarine Main Sea Water (MSW) cooling system containing 2 pumps, 2 main condensers, 2 heat exchangers and 75 feet of piping were cleaned.

Using cost figures developed from the production control system at PSNS, the new process has, in FY 2000, saved an average of over $ 520,000 for each submarine system and $ 70,000 for each single heat exchanger cleaned when compared to the old mechanical cleaning process.

A similar chemical cleaning process has been approved for cleaning shipboard Consolidated Holding Tanks (CHT).

In the end, this process improvement is safer, more cost efficient and in some states, the effluent can be disposed as Industrial Waste at a considerable savings. It is an excellent example of how pollution prevention can reduce waste and environmental costs but have a larger savings in operations, maintenance and life cycle costs. It is also an excellent example of how pollution prevention improves the quality of life of our Navy sailors and civilians, and increases the mission readiness of our ships and submarines. ⚓

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